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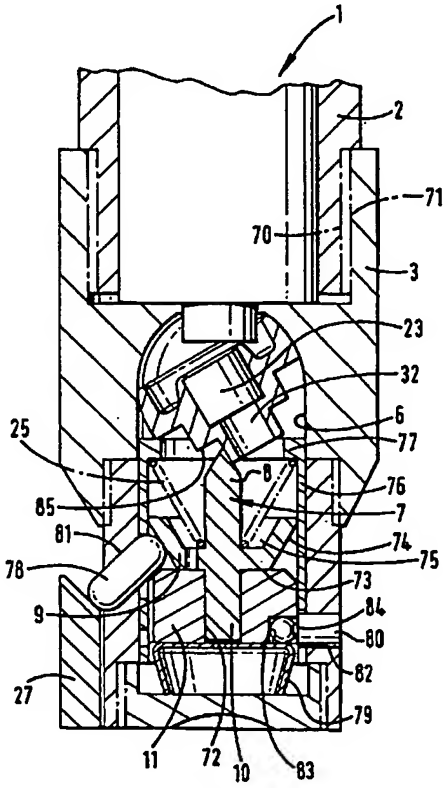
(54) Title: SAFETY SYSTEM FOR A PROJECTILE FUSE

(57) Abstract

The invention provides a safety system for a small arms projectile in which an initiating device is impacted by a firing member in order to detonate a main explosive charge. The system requires the firing member to be retained in a safe position in relation to the initiating device by at least two independent mechanisms. The firing member is initially supported in a forward position, in which it assists in holding the initiator device in a safe condition, and is caused to move rearwardly, through inertia, when the projectile is fired, destroying one of the retaining mechanisms and allowing the initiator device to adopt a primed position in which it can be activated by the firing member which at this time is retained by the other retaining mechanism which is automatically released when the projectile is in flight. The initiator device may, when held in its safe condition, be skewed with respect to the main explosive charge and may incorporate or support a shield disposed, in the safe condition, between the initiator device and the main explosive charge.



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SAFETY SYSTEM FOR A PROJECTILE FUSE

The present invention relates to a safety system particularly for a small arms projectile for a small arms weapon.

In our European Patent EP-B-0363079 there is described a small arms projectile for a smooth bore weapon preferably fired from a cartridge with a propellant charge therein, wherein the projectile comprises a generally cylindrical casing, a warhead assembly, said warhead being hollow to accommodate an explosive charge and an initiator therefor, the casing being formed with a firing pin spring biased to a safety position and locked in the safety position by at least one spring biased safety pin, wherein the spring biased safety pin is adapted to release on exit of the projectile from the muzzle of the small arm weapon.

EP-B-0363079 thus describes a projectile having a mechanical safety means for retaining the firing pin in the safety position. The mechanical safety means comprises at least one spring biased safety pin extending normal to the axis of the firing pin and located in a radial bore in the firing pin to prevent axial movement of the firing pin. The safety pin is radially retained by the cartridge.

There is a drawback associated with this arrangement. When the projectile leaves the muzzle of the small arm there is a severe deceleration as it hits still air and this causes the projectile casing to decelerate and a deceleration force to be applied to the firing pin in the direction of the initiator. The shear force applied to the safety pin by the deceleration between the casing and the firing pin prevents ejection of the safety pin until the shear force is overcome by the spring biassing force acting on the pin. The firing pin is thus retained in its safety position by the safety pin. Only when the shear force has reduced will the safety pin release the firing pin. The effect of this is to delay the arming of the projectile by at least 0.1 seconds (or about 10 metres), or more reliably 0.2 to 0.3 seconds, which equates

generally to about 20 or 30 metres down range. This means that targets at short range cannot be engaged and even targets of 25 to 30 metres cannot always be engaged reliably.

A further drawback with this arrangement is that there is only one safety means for retaining the firing pin in the safety position. There is a possibility therefore that the explosive charge could be initiated accidentally if the safety pin became dislodged from the firing pin due to the cartridge being damaged, for example.

In order to address these problems EP-B-0363079 suggests the use of a chemical safety means in addition to the mechanical safety means. The chemical safety means includes a layer of combustible adhesive material interposed between the firing pin and an adjacent hollow portion of the casing. The combustible adhesive material is connected to a bore at the rear of the casing adjacent a propellant charge so that it is activated by the explosion of the propellant charge when the projectile is fired.

In this arrangement the combustible adhesive material retains the firing pin in its safe position for a pre-determined period once the projectile has been fired. This prevents any shear forces being generated between the firing pin and the safety pin as the projectile decelerates on hitting still air. In this way ejection of the safety pin occurs immediately the projectile leaves the muzzle of the small arm. The time taken for the combustible adhesive material to release the firing pin and thus arm the projectile is determined by the characteristics of the combustible adhesive material.

A problem with this arrangement is that the combustible adhesive material may deteriorate and become unstable if stored for a prolonged period, particularly if the adhesive is in any way defective. This is a major drawback if a long shelf life is required as is usual for ammunition.

A further problem associated with this arrangement is that manufacturing constraints can result in the combustible adhesive material being insufficiently reliable to ensure that

any delay in arming equates to about 3 metres from the user when the projectile is fired.

An object of the present invention is to provide a small arms projectile which has a safety means for retaining a firing pin in a safety position prior to firing and releasing the firing pin on application of acceleration forces consequent upon on firing.

Another object of the present invention is to provide a small arms projectile which has at least two mechanically independent safety means for retaining a firing pin in a safety position prior to firing.

Another object of the present invention is to provide a small arms projectile which has a safety means for retaining a firing pin in a safety position prior to firing which operates to delay the arming of the projectile on firing in a more reliable manner than hitherto known safety means.

According to an aspect of the present invention there is provided a small arms projectile for a small arms weapon, said projectile comprising a generally cylindrical casing, a warhead and an initiator, said warhead having an explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by a safety release means, wherein the safety release means restrains the firing pin in the safety position on application of acceleration forces less than 500g and causes the firing pin to be released from the safety position on application of acceleration forces determined upon the projectile being fired in the bore of a small arms weapon.

It will be understood that the abbreviation "g" used herein represents the acceleration due to gravity. Typically a small arm projectile will experience an acceleration of between 10,000g and 15,000g when fired in the bore of a small arms weapon. The safety release means retains the firing pin in the safety position on application of acceleration forces less than 500g to prevent accidental arming of the projectile prior to firing. In this way the releasable safety means will

protect the user if the projectile is accidentally dropped during handling since the acceleration forces applied to the projectile will generally be less than 500g.

Preferably, said safety release means includes at least one primary mechanical releasable restraining means and at least one secondary mechanical releasable restraining means, and wherein the firing pin is caused to be released from said safety position by release of said primary and secondary mechanical restraining means in a pre-determined sequence when the projectile is fired. In this way if one of the mechanical releasable retaining means fails the other will prevent movement of the firing pin from the safety position to the initiator. Since both the releasable restraining means are mechanical, restraint of the firing pin is improved and problems associated with chemical degradation are avoided.

Preferably, said primary mechanical releasable restraining means is releasable from the firing pin only after said secondary mechanical releasable restraining means has been released. This can prevent the firing pin moving towards the initiator when the projectile exits the muzzle of the small arm.

Conveniently, said primary mechanical releasable restraining means is released from the firing pin by initial axial movement of the firing pin in a direction away from the initiator. The acceleration forces applied to the firing pin on firing can thus be used to release the firing pin from the primary mechanical releasable restraining means.

In preferred embodiments, said secondary mechanical releasable restraining means includes a frangible element disposed between a base of the firing pin and the casing. The firing pin can thereby be restrained by the frangible element.

Preferably, the strength of the frangible element is such that it prevents axial movement of the firing pin in a direction away from the initiator prior to firing and is crushed by axial movement of the firing pin in said axial direction on firing. In this way the frangible element

prevents release of the firing pin from the primary mechanical releasable restraining means until significant acceleration forces are applied to the firing pin when the projectile is fired. The acceleration forces applied to the firing pin on firing are considerable and in this way the frangible element can be made sufficiently strong to withstand shock loads due to mis-handling prior to firing.

Conveniently, the strength of the frangible element is sufficient to withstand acceleration forces applied to the firing pin up to 500g. In this way the frangible element will readily break when the projectile is fired but its structure will prevent axial movement of the firing pin and release of the primary mechanical releasable retaining means prior to firing.

In preferred embodiments, the frangible element is a hollow disc. In this way the frangible element can be readily fabricated and its breaking strength reliably controlled during manufacture.

Preferably, the initiator is movable between an unarmed position and a biased armed position and is retained in the unarmed position by engagement with the firing pin in the safety position. In this way the initiator can not be armed until the firing pin is moved from the safety position and disengaged from the initiator.

Conveniently, the initiator is rotatable about an axis perpendicular to the axis of said casing. In this way the initiator can rotate to the biased armed position once the firing pin has disengaged on firing.

In preferred embodiments, the firing pin is biased in an axial direction away from the initiator. This can prevent movement of the firing pin towards the initiator once the projectile has been fired.

Preferably, the firing pin is biased by a compression spring having sufficient stiffness to prevent axial movement of the firing pin into the initiator due to the deceleration of the projectile as it leaves the muzzle of a small arm. This prevents movement of the firing pin towards the

initiator immediately the projectile exits the muzzle of the small arm. In this way the firing pin strikes the initiator only when the projectile impacts the target.

Conveniently, said primary mechanical releasable restraining means includes at least one spring biased safety pin. In this way the safety pin can be radially restrained in a cartridge from which the projectile is fired. The safety pin is radially restrained by the internal surface of the bore of the weapon from which it is fired and is released on exit from the muzzle. The projectile is thus armed either immediately on exit or within a short distance after exiting the muzzle of the shotgun.

In preferred embodiments, two spring biased safety pins are provided for release in opposite radial directions. This avoids any imbalance of the projectile once it has been fired.

Preferably, said safety pin includes a detent at its remote end which is engaged by the firing pin in the safety position. The safety pin is thus readily engaged by the firing pin.

According to another aspect of the present invention there is provided a small arms projectile for a small arms weapon, said projectile comprising a generally cylindrical casing a warhead and an initiator, said warhead having an explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by at least one biased releasable safety pin and a frangible element disposed between a base of the firing pin and the casing, said safety pin being released by axial movement of the firing pin in a direction away from the initiator, and whereby the frangible element prevents axial movement of the firing pin in a said axial direction prior to firing and is crushed by movement of the firing pin in said axial direction on firing thereby to cause the firing pin to be released.

According to a further aspect of the present invention there is provided a small arms projectile for a small arms

weapon, said projectile comprising a generally cylindrical casing, a warhead and an initiator, said warhead having an explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by at least one primary mechanical releasable restraining means and at least one secondary mechanical releasable restraining means, and wherein the firing pin is caused to be released from said safety position by release of said primary and secondary mechanical restraining means in a pre-determined sequence when the projectile is fired.

In a preferred embodiment, said primary mechanical releasable restraining means is releasable from the firing pin independently of said secondary mechanical releasable restraining means. In this way, one of the mechanical releasable restraining means can be used independently for delay arming purposes.

Preferably, said secondary mechanical releasable restraining means includes a plurality of radially movable elements which engage a circumferential periphery of the firing pin to prevent axial movement of the firing pin prior to firing, and a plurality of fins circumferentially spaced about an outer periphery of the casing and pivotally connected thereto, the fins being at least partially retained in a folded down condition in a cartridge case and biased to deploy radially outwardly relative to the casing as the projectile leaves the muzzle of a small arm thereby to cause the projectile to rotate about its axis and cause the radially movable elements to move radially outwards under centrifugal force to release the firing pin. In this way, movement of the firing can be delayed for a pre-determined period once the projectile exits the muzzle of the small arm from which it has been fired.

The warhead may be formed of a hollow casing preferably provided with a number of fragmentation recesses about its internal or external periphery. In another embodiment the hollow casing is interfitted with a fragmented helical spring

over which the explosive is cast in manufacture. The warhead may also optionally be provided towards its intended forward portion with a sealant recess accommodating a soft plastic sealant ring which in use contacts the bore of the smooth bore weapon. The sealant ring, which is soft, ensures a proper seal between the projectile and the bore even if the bore is in some way deformed.

Internally the warhead is provided with a standard explosive such as A5. The warhead is also provided towards its rear end with an initiator which is either held on a support plate immediately adjacent the rear of the charge, or interfits in a recess in the charge itself.

The casing may be formed of aluminium or steel depending upon weight requirements or alternatively may be moulded from an epoxy resin into which ball bearings to the necessary weight have been dispersed. The casing may be similarly provided in steel, aluminium or mouldable plastics material such as epoxy resin. The casing may be provided with a tracer compound initiated by the propellant charge if desired.

According to a still further aspect of the invention there is provided a small arms projectile for a small arms weapon, said projectile comprising a generally tubular casing, a warhead and an initiator, said initiator comprising a first explosive charge, detonatable in response to mechanical impact, and said warhead having a second explosive charge, detonatable by exposure to said first explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by a safety release means, wherein said initiator comprises means for causing said first explosive charge to conform to a predetermined shape about an initiator axis and said initiator axis is misaligned with the axis of motion of said firing pin when said safety release means restrains the firing pin in the safety position.

The invention will now be described, by way of illustration only, with reference to the accompanying drawings in which:-

Figure 1 is a vertical cross-section view of a projectile in accordance with an embodiment of the present invention removed from a 3" (7.56 cm) 12 gauge cartridge;

Figure 2 is a cross-section view similar to Figure 1 and shows a projectile of another embodiment of the present invention;

Figure 3 is a cross-section view similar to Figure 1 and shows a projectile of a further embodiment of the present invention;

Figure 4 is a cross-section view similar to Figure 1 and shows a projectile of a further embodiment of the present invention;

Figures 5(a) and 5(b) are partial cross-section views showing an alternative relationship between initiator and warhead components to that shown in the previous figures in safe (but accidentally triggered) and armed conditions respectively; and

Figure 6 is a cross-section view showing a further alternative relationship between the initiator and warhead components.

In all Figures, similar components of the small arm projectiles of the different embodiments bear the same reference numerals.

With reference to Figure 1, the projectile (1) is formed with a hollow warhead (2) and a hollow casing (3). The projectile has a generally cylindrical configuration about a central axis and is formed in this instance of aluminium castings. The warhead (2) and the casing (3) are separately formed castings provided with interlocking means in the form of an externally threaded portion (4) on the casing and an internally threaded portion (5) on the warhead. The warhead and casing are joined together immediately prior to assembly with a 12-bore cartridge.

The casing (3) is provided with an axial bore (6) which accommodates an axially movable cylindrical firing pin (7). The firing pin (7) is provided at its operative end nearest the warhead (2) with a conical needle portion (8) for

contacting an explosive charge initiator (23) which is located in the warhead. The firing pin (7) also includes a stabilising disc portion (9) adjacent the needle portion, a reduced diameter shaft portion (10) adjacent the stabilising disc and a base portion (11). The stabilising disc (9) and base portion (11) have an external diameter which is substantially the same as the internal diameter of the axial bore (6). The base potion (11) includes an annular recess (12) on its side adjacent the reduced shaft portion (10).

In the drawing the firing pin (7) is shown in its safety position. The firing pin (7) is retained in this position by a safety release means which includes a primary mechanical releasable restraining means in the form of two diametrically opposite spring biased safety pins (13), and a secondary releasable mechanical restraining means in the form of a hollow frangible disc element (15).

The safety pins (13) are each located in a stepped throughbore (16) in the casing (3). The throughbores (16) have an axis which is perpendicular to the axis of the casing (3). The safety pins (13) include a pin cap portion (17) and a shaft portion (18) which locates in the reduced diameter portion of the stepped throughbore (16). The shaft portion (18) of the safety pin has an external diameter which is substantially the same as the internal diameter of the reduced diameter portion of the throughbore. A compression spring (19) is provided in the larger diameter portion of the stepped throughbore (16) and bears upon the pin cap portion (17) to bias the safety pin (13) radially outwards. The safety pins (13) are held in the throughbore by engagement with the firing pin (7). At their remote ends the safety pins each include a reduced diameter portion (20) adjacent the shaft portion (18) and a outwardly splayed conical portion (21) which defines a detent. The reduced diameter portion (20) extends from the stepped throughbore and engages the forward axial face (22) of the base portion (11). The outwardly splayed conical portion (21) is partly located in the annular recess (12) and prevents axial movement of the

firing pin (7) in the direction of the initiator (23).

By virtue of the fact that the safety pins (13) are retained by the firing pin (7) assembly is simplified considerably since it is no longer necessary to manually retain the safety pins (13) in their pre-expanded condition prior to locating the same in a cartridge for use.

The hollow frangible disc element (15) is positioned between the base portion (11) of the firing pin (7) and an annular back plate (24) which is attached to the casing (3). The strength of the frangible element is such that it prevents axial movement of the firing pin in a direction away from the initiator prior to firing and is crushed by axial movement of the firing pin in said axial direction on firing. In this respect the frangible element can withstand acceleration forces applied to the firing pin up to 5000g.

A compression spring (25) is disposed around the conical portion (8) of the firing pin (7). The compression spring is retained by engagement with the stabilising disc portion (9) and an annular retaining plate (26) which is secured to the interior surface of the casing (3). The annular retaining plate (26) includes a central aperture (30) for receiving the conical portion (8). In the safety position shown the compression spring does not apply a significant load to the safety pin.

Located at the remote end of the casing (3) and about the external periphery thereof are four fins (27) which in use extend radially outwardly from the body of the casing (3). The fins (27) are of an accurate configuration such that in their folded-down position within the cartridge or barrel for example they will lie over the external periphery of the casing. To this end the fins (27) are hinged at (28), the axis of the hinge being slightly angled to the longitudinal axis of the projectile such that air pressure will cause the fins (27) to open and to spin the projectile when it has exited from the muzzle of the weapon. The fins (27) may be formed of a resilient material such as copper, or may be moulded into their final form of plastics or a

mouldable metal such as aluminium. Although the present invention is described with reference to fins it is appreciated that the invention also refers to projectiles not including fins.

The warhead assembly (2) is formed of an aluminium casting of a generally cylindrical configuration and includes a domed forward end. The domed forward end conjoins the cylindrical portion which extends downwardly towards the casing (3). The hollow portion of the warhead (2) is provided with an explosive (29), for example A5. The block of explosive (29) is in this particular embodiment provided with a central bore (31) for the accommodation of an initiator (23) which in this particular instance defines part of a shutter mechanism. The initiator (23) is rotatably mounted on an axis perpendicular to the axis of the warhead (2) for movement between the angular position shown and a spring biased position 90 degrees apart. The initiator (23) is provided with a wedge shape slot (41) which engages the tip of the conical portion (8) when the firing pin is in the safety position. In this way the firing pin (7) retains the initiator (23) in the unarmed angular position shown. Spring biassing means (not shown) are provided for rotating the initiator (23) by 90 degrees to an armed position when the firing pin is moved relatively rearwardly. The initiator (23) is further provided with apertures (32) for receiving the tip of the conical portion (8) when rotated to the armed position.

Pre-moulded fragmentation portions (not shown) may also be formed on the internal or external faces of the warhead (2). In an alternative the warhead (2) may be formed of a hard epoxy resin into which a plurality of ball bearings have been exposed. The advantage of this latter construction is that the weight of the warhead (2) can be carefully adjusted by means of the utilisation of the correct weight and number of ball bearings. Further of course the point of balance of the projectile assembly can be altered by placing the ball bearings at various positions in varying numbers within the

body of the material forming the warhead (2).

In use the explosive charge which is moulded to a predetermined shape is interfitted in the warhead (2) and the initiator (23) positioned therein. The casing (3) is assembled by positioning the frangible disc element (15) at the base of the bore (6) of the casing (3) once the firing pin (4) is introduced into the bore (6). The safety pins (13) are then introduced to the bore (6) and pressed home. With the cap portion (17) of the safety pins (13) retained in its pressed-in condition the firing pin (7) is then in retained in its safety position and the casing (3) and the warhead (2) may be then screwed together. If in this position the projectile is accidentally dropped even with the cartridge casing removed the concussion will not release the firing pin (7) because the safety pins (13) are inter-engaged therewith and the frangible disc element (15) is sufficiently strong not to break. Subsequently the fins (27) are positioned in their radially inward positions and the device is slipped into a standard 12-bore cartridge so as to fit on top of the wadding immediately over the propellant charge.

The cartridge may then be positioned in a standard shotgun with a cylindrical barrel and fired in a normal way. On firing the projectile (1) leaves the cartridge (not shown) and travels along the smooth bore barrel. The acceleration force applied to projectile in the barrel is typically in the range 10000g to 15000g. The acceleration force of the firing pin (7) causes the firing pin (7) to crush the frangible disc element (15). This allows the firing pin to move in an axial direction away from the initiator (23). The initiator (23) is thereby released from its unarmed position and rotates about its axis through 90 degrees to its armed position. As the firing pin moves rearwards away from the initiator (23) the safety pins (13) become dis-engaged from the annular recess (12). On exit from the barrel the restraint from the internal wall of the bore is removed and the safety pins (13) are immediately ejected radially outwards.

On exiting the barrel the projectile decelerates since

the pressure of the propellant gases in the barrel no longer act upon it. The deceleration of the projectile urges the firing pin (7) towards the initiator (23). Contact between the firing pin (7) and the initiator (23) is avoided at this stage by the forward motion of the firing pin being countered by the restraining force applied by the compression spring (25). When the projectile (1) impacts the target, the deceleration forces upon it are very much greater and the associated force acting on the firing pin (7) overcomes the restraining force of the compression spring (25) and the tip of the firing pin (7) enters the aperture (32) of the initiator, thereby causing the charge to explode.

With reference now to Figure 2, the projectile (1) is substantially the same as the projectile of Figure 1. The projectile of Figure 2 differs from that of Figure 1 in the sense that the firing pin (7) includes two separate components. The conical tip portion (8), the stabilising disc (9) and the reduced diameter shaft portion (10) are formed as one component, and the base portion (11) is formed as a separate component. The base portion (11) is provided with a central blind bore (60) and an annular flange (61) at its outer radial periphery on its forward axial face (22). The reduced diameter shaft portion (10) is located in the blind bore (60) at its end furthest from the tip portion (8). The reduced diameter portion has an external diameter substantially the same as the internal diameter of the blind bore (60) and includes a shoulder (62) positioned part way along its length which is urged into engagement with a stepped annular recess (63) at the opening of the blind bore (61) by the compression spring (25). The safety pins (13) have a constant diameter shaft portion (18) which includes a slot (64). The slot (64) provides a detent which engages the annular flange (61) to prevent axial movement of the firing pin (7) in the direction of the initiator (23). In this respect it will be understood that the slot (64) and annular flange (61) replace the reduced diameter portion (20) and outwardly splayed conical portion (21) of the safety pins

(13) and the annular recess (12) of the projectile of Figure 1.

The projectile of Figure 2 is fired in an identical manner to the projectile of Figure 1. On firing the acceleration force applied to the base portion (11) causes the base portion (11) to crush the frangible disc element (15). This allows the base portion (11) to move in the axial direction away from the initiator (23) relative to the shaft portion (10). As the base portion (11) moves rearwards away from the initiator (23) the safety pins (13) become disengaged from the annular flange (61). Axial movement of the shaft portion (10) in the direction away from the initiator is prevented by engagement of the safety pins (13) with the disc portion (9). The initiator (23) is thereby held in its unarmed position by engagement of the tip portion (8) and the V-groove (41). On exit from the barrel the safety pins eject radially outwards and the biassing force of the compression spring (25) urges the shaft portion (10) towards the base portion (11) in the axial direction away from the initiator (23). This causes the initiator (23) to be released from its unarmed position. The initiator (23) then rotates through 90 degrees to its armed position to arm the projectile.

With reference now to Figure 3, the projectile (1) is substantially the same as the projectile of Figure 1. The projectile of Figure 3 is different from that of Figure 1 in the sense that the safety pins (13) have a constant diameter shaft portion (42) which extends from the cap portion (17). In Figure 3 the safety pins (13) are radially restrained in the throughbores (16) by the interfitting cartridge. In the safety position shown, the safety pins (13) can engage the forward facing axial side (22) of the of the base portion (11) to prevent axial movement of the firing pin (7) in the direction of the initiator (23), and can also engage the opposing axial side of the stabilising disc (9) to prevent axial movement of the firing pin (7) in the direction away from the initiator.

The secondary mechanical releasable restraining means is

provided by a plurality of circumferentially spaced radially movable elements (43). The elements (43) have a generally L-shaped cross-section and are interfitted in an annular groove (44) formed in a reduced diameter portion (45) of the firing pin (7) adjacent the base portion (11). The elements (43) are biased radially inwards into the annular groove (44) by spring biassing means (46) between the elements (43) and the casing (3). The elements (43) are accommodated in an annular recess (47) formed in the bore (6) at the end of the casing remote from the warhead (2). The annular recess (47) defines a stepped axial surface (49) in the bore (6). The radial dimension of the elements (43) is such that in the biased position shown the elements (43) extend radially outwards of the annular recess (44) and part way along the axial surface (48) into the annular recess (47). In this position the elements (43) define a radial gap (50) between the casing and their radially outer ends. Also in this position the elements (43) prevent axial movement of the firing pin (7) in the direction towards the initiator (23) by engagement with the stepped axial surface (49). The radial dimension of the gap (50) is marginally greater than that of the annular recess (45). The firing pin (7) is axially aligned in the bore (6) by location of its end furthest from the conical portion (8) in an aperture (51) provided in the end plate (24).

The initiator (23) is non-movably retained in the explosive (29) by the annular plate (26).

On firing the projectile (1) leaves the cartridge (not shown) and travels along the smooth bore barrel. On exit from the barrel the restraint of the internal walls of the bore is removed and the safety pins (13) are immediately ejected. Movement of the firing pin (7) towards the initiator (23) is then prevented by engagement of the elements (43) and the axial surface (49) only. As the projectile exits from the barrel the fins (27) deploy and cause the projectile to rotate about its axis. At a predetermined point the rotation of the projectile generates sufficient centrifugal force on the elements (43) to force them radially outwards against the

biassing force of the spring biassing means (46). When the elements (43) engage the annular recess (47) they disengage from the annular recess (45) and thereby release the firing pin(7). This will generally occur 0.3 seconds after exiting the barrel resulting in a delay arming of the projectile equating to about 30 yards down range which is just far enough to ensure the safety for the user. Once the projectile is armed the tip of the firing pin (7) can enter the initiator on impact with the target being engaged.

The projectile of Figure 3 therefore provides a projectile for a smooth bore weapon with a novel delay arming device, and a novel arming device per se.

With reference to Figure 4, in another embodiment the projectile (1) is formed in a similar way to the embodiments of Figures 1 to 3 with a hollow warhead (2) and a hollow casing (3). In the drawing of Figure 4 the detail of the warhead (2) has been omitted for clarity. The warhead (2) and casing (3) are separately formed castings with interlocking means in the form of an externally threaded portion (70) on the warhead (2) and an internally threaded portion (71) on the casing (3).

The projectile of Figure 4 is provided with a two piece firing pin (7). The firing pin (7) of the projectile of Figure 4 is similar to the firing pin (7) of the projectile of Figure 2 in the sense that the conical tip portion (8), the stabilising disc (9) and the shaft (10) are formed as one component, and the base portion (11) as a separate component. The shaft portion (10) is located in a central throughbore (72) in the base portion (11). In the embodiment of Figure 4 the stabilising disc comprises a flat base (73) and a frusto conical side potion (74) which together provide a recess (75) on the initiator side of the stabilising disc. A cylindrical sleeve (76) is located in the bore (6) of the casing (3) adjacent the firing pin (7). An annular shoulder (77) is provided at the end of the sleeve (76) nearest the firing pin tip (8) to receive one end of a compression spring (25). The other end of the compression spring is located in the recess

(75) to urge the flat base (73) of the stabilising disc into engagement with the base (11).

In the embodiment of Figure 4, the firing pin (7) is retained in the safety position shown by a primary mechanical releasable restraining means comprising at least one spring biased safety pin (78), and secondary releasable mechanical restraining means in the form of a frangible disc element (79). In this embodiment the safety release means additionally comprises a tertiary mechanical releasable restraining means in the form of at least one shear pin (80) disposed in a recess (83) in the base (11).

The safety pin (78) is located in an inclined throughbore (81) in the side of the casing (3). At one end the safety pin (78) engages the frusto-conical side portion (74) of the stabilising disc (9). The safety pin (78) is spring loaded in a radially outwards direction by the compression spring (25) acting on the disc (9) and are restrained within its throughbore (31) by a fin (27) when in its folded-down condition as shown.

The shear pin (80) is located in a throughbore (82) in the side of the casing (3) and extends within a recess (83) provided in the base (11). The shear pin (80) is provided with a reduced diameter frangible portion (84) which is positioned to correspond to the position between the recess (83) and the throughbore (82).

In the embodiment of Figure 4 the spring biased initiator (23) is located within the bore (6) of the casing. In this embodiment the initiator (23) is provided with a stepped outer surface (85) which is engaged by the tip of the conical portion (8) when the firing pin is in the safety position. The initiator (23) is spring loaded to its armed position which corresponds to the aperture (32) being aligned with the axis of the firing pin.

The projectile of Figure 4 is fired in an identical manner to the projectiles of Figure 1 to 3. On firing, the acceleration force applied to the base portion (11) causes the base portion (11) to crush the frangible disc element

(79) and the shear pin (80) to shear. This allows the base portion (11) to move in the axial direction away from the initiator (23) relative to the shaft portion (10). Axial movement of the shaft portion (10) in the direction away from the initiator is prevented by engagement of the safety pin (78) with the frusto-conical portion (74). The initiator (23) is thereby held in its unarmed position by engagement of the tip portion (8) with the stepped outer surface (85) when in the barrel of the smooth bore weapon. On exit from the barrel the fins (27) deploy and the safety pin (78) eject radially outwards and the biassing force of the compression spring (25) urges the shaft portion (10) towards the base portion (11) in the axial direction away from the initiator (23). This causes the initiator (23) to be released from its unarmed position. The initiator (23) then rotates through approximately 30 degrees to its armed position to arm the projectile.

The embodiment of Figure 4 has been described as comprising a single safety pin (78) and a single shear pin (80). In another embodiment these are supplemented by a second safety pin (78) and shear pin (80) positioned diametrically opposite each other respectively.

The embodiment of Figure 4 provides a further and highly significant improvement in the safety of projectiles of this kind, based upon the important fact that, until the initiator (23) is permitted to move into its armed position, there is neither a direct line of impingement of the firing pin (7) into the initiator nor a direct line of communication between the initiator and the explosive (29). This is used to further advantage in the embodiments of the invention illustrated in part in Figures 5(a), 5(b) and 6.

Referring now to Figure 5(a), it can be seen that the initiator (23) is contained within a cup-like construction (90), made of aluminium, and preferably surrounded with titanium foil (91), or otherwise coated with or bearing a layer of titanium, of thickness in the order of 0.001 inch. The warhead's explosive charge (29) is contained behind a

shield (92) which adopts a top-hat like shape towards the initiator (23) with a thinned central portion (93). The cup-like structure (90, 91) is formed with a lid part (94), which faces towards the shield (92) so that, in general, when the projectile is safe, the lid part (94) lies in front of and parallel to the thinned portion (93) of the shield (92) when the initiator (23) is not in line with the main charge. By this means, there is provided a shaping of the initiator's charge and a shielding of the main charge (29) whereby, in the event of an accidental triggering of the initiating charge by some external agency, as indicated by the fracture of the lid part (94), the energy of the charge does not directly impact the main charge (29), as it is skewed away from the direct "line of sight" thereto, and moreover the lid part (94) of the cup-like structure (90,91) tends to be opened out, as shown at 94a, and thus provides a strengthened shield between the initiating charge and the main explosive charge (29) of the projectile.

Figure 5(b) is identical to Figure 5(a), except that it shows the armed condition, wherein the cup-like structure (90, 91) has been allowed to rotate so as to align the charge (23) with the thinned region (93) of the shield (92). In this condition, when the initiator charge is fired, as shown, the opened-out portions of the lid part (94) no longer overlie the thinned region (93) of the shield (92) and indeed assist in concentrating the initiator's charge into the main explosive charge (29) of the warhead; i.e. they provide a "fire channel" directing the initator's energy to the main charge.

In the arrangement of Figure 6, the principal difference from that of Figure 5 is that there is provided a shielding shutter (95) that is integral with, and thus rotates with, the initiator (23), thereby obviating the need for the lid part (94) to the cup-like structure (90, 91) which is otherwise as described in relation to Figure 5. The shutter (95) is shaped, dimensioned and crafted of suitable material to resist or at least lessen the impact on the main explosive

charge (29) of an accidental discharge of the initiator charge. In this respect, it can be made relatively bulky since, of course, it is automatically moved out of the line of action between the initiator (23) and the main explosive charge (29) of the projectile when the initiator rotates to its armed position.

The combination, as shown in Figures 5 and 6, of shaping, at least to an extent, the initiator's charge, skewing the shaped charge, with respect to the direct path to the main explosive charge, in an "unarmed" condition, and providing additional shielding along the direct path in the "unarmed" condition, provides a significant degree of additional safety against unwanted detonation of the main charge whilst not compromising the sensitivity of the warhead to detonation in the "armed" condition, when the initiator charge is rotated to align with the direct path to the main explosive charge.

It will be understood that the illustrated embodiments described herein show an application of the invention in one form only for the purposes of illustration. In practice the invention may be applied to many different configurations the detailed embodiments being straightforward to those skilled in the art to implement.

CLAIMS:-

1. A small arms projectile for a small arms weapon, said projectile comprising a generally cylindrical casing, a warhead and an initiator, said warhead having an explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by a safety release means, wherein the safety release means restrains the firing pin in the safety position on application of acceleration forces less than 500g and causes the firing pin to be released from the safety position on application of acceleration forces determined upon the projectile being fired in the bore of a small arms weapon.

2. A small arms projectile according to claim 1 wherein said safety release means includes at least one primary mechanical releasable restraining means and at least one secondary mechanical releasable restraining means, and wherein the firing pin is caused to be released from said safety position by release of said primary and secondary mechanical restraining means in a pre-determined sequence when the projectile is fired.

3. A small arms projectile according to claims 1 or 2 wherein said primary mechanical releasable restraining means is releasable from the firing pin only after said secondary mechanical releasable restraining means has been released.

4. A small arms projectile according to claim 3 wherein said primary mechanical releasable restraining means is released from the firing pin by axial movement of the firing pin in a direction away from the initiator.

5. A small arms projectile according to any one of claims 2 to 4 wherein said secondary mechanical releasable restraining means includes a frangible element disposed between a base of

the firing pin and the casing.

6. A small arms projectile according to claim 5 wherein the strength of the frangible element is such that it prevents axial movement of the firing pin in a direction away from the initiator prior to firing and is crushed by axial movement of the firing pin in said axial direction on firing.

7. A small arms projectile according to claim 6 wherein the strength of the frangible element is sufficient to withstand acceleration forces applied to the firing pin up to 500g.

8. A small arms projectile according to any one of claims 5 to 7 wherein the frangible element is a hollow disc.

9. A small arms projectile according to any preceding claim wherein the initiator is movable between an unarmed position and a biased armed position and is retained in the unarmed position by engagement with the firing pin in the safety position.

10. A small arms projectile according to claim 9 wherein the initiator is rotatable about an axis perpendicular to the axis of said casing.

11. A small arms projectile according to any preceding claim wherein the firing pin is biased in an axial direction away from the initiator.

12. A small arms projectile according to claim 11 wherein the firing pin is biased by a compression spring having sufficient stiffness to prevent axial movement of the firing pin into the initiator due to the deceleration of the projectile as it leaves the muzzle of a small arm.

13. A small arms projectile according to any one of claims 2 to 12 wherein said primary mechanical releasable restraining

means includes at least one spring biased safety pin.

14. A small arms projectile according to claim 13 wherein two spring biased safety pins are provided for release in opposite radial directions.

15. A small arms projectile according to claims 13 or 14 wherein said safety pin includes a detent at its remote end which is engaged by the firing pin in the safety position.

16. A small arms projectile for a small arms weapon, said projectile comprising a generally cylindrical casing, a warhead and an initiator, said warhead having an explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasable restrained in a safety position by at least one biased releasable safety pin and a frangible element disposed between a base of the firing pin and the casing, said safety pin being released by axial movement of the firing pin in a direction away from the initiator, and whereby the frangible element prevents axial movement of the firing pin in said axial direction prior to firing and is crushed by movement of the firing pin in said axial direction on firing thereby to cause the firing pin to be released.

17. A small arms projectile for a small arms weapon, said projectile comprising a generally cylindrical casing, a warhead and an initiator, said warhead having an explosive charge and an initiator, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by at least one primary mechanical releasable restraining means and at least one secondary mechanical releasable restraining means, and wherein the firing pin is caused to be released from said safety position by release of said primary and secondary mechanical restraining means in a pre-determined sequence when the projectile is fired.

18. A small arms projectile according to claim 17 wherein said primary mechanical releasable restraining means is releasable from the firing pin independently of said secondary mechanical releasable restraining means.

19. A small arms projectile according to claims 17 or 18 wherein said secondary mechanical releasable restraining means includes a plurality of radially movable elements which engage a circumferential periphery of the firing pin to prevent axial movement of the firing pin prior to firing, and a plurality of fins circumferentially spaced about an outer periphery of the casing and pivotally connected thereto, the fins being at least partially retained in a folded down condition in a cartridge case and biased to deploy radially outwardly relative to the casing as the projectile leaves the muzzle of a small arm thereby to cause the projectile to rotate about its axis and cause the radially movable elements to move radially outwards under centrifugal force to release the firing pin.

20. A small arms projectile according to any one of claims 17 to 19 wherein said primary mechanical releasable restraining means is a spring biased safety pin.

21. A small arms projectile according to claim 20 wherein two spring biased safety pins are provided for release in opposite radial directions.

22. A projectile according to any preceding claim wherein said initiator is constructed to generate an initiating explosive charge in response to impact thereon of said firing pin and comprises means for causing said initiating explosive charge to conform to a predetermined shape about an initiator axis and wherein said initiator axis is misaligned with the axis of motion of said firing pin when said safety release means restrains the firing pin in the safety position.

23. A small arms projectile for a small arms weapon, said projectile comprising a generally tubular casing, a warhead and an initiator, said initiator comprising a first explosive charge, detonatable in response to mechanical impact, and said warhead having a second explosive charge, detonatable by exposure to said first explosive charge, the casing having an axially movable firing pin for impact with said initiator, the firing pin being releasably restrained in a safety position by a safety release means, wherein said initiator comprises means for causing said first explosive charge to conform to a predetermined shape about an initiator axis and said initiator axis is misaligned with the axis of motion of said firing pin when said safety release means restrains the firing pin in the safety position.

24. A projectile according to claim 22 or claim 23 wherein, when said initiator axis is misaligned with the axis of motion of said firing pin, shielding means is interposed between the explosive charges.

25. A projectile according to claim 24 wherein said first explosive charge is contained in a cup-like structure and said shield comprises a portion of said structure.

26. A projectile according to claim 25 wherein the cup-like structure is made of aluminium and titanium.

27. A small arms projectile substantially as herein described and/or with reference to the accompanying drawings.

FIG. 1

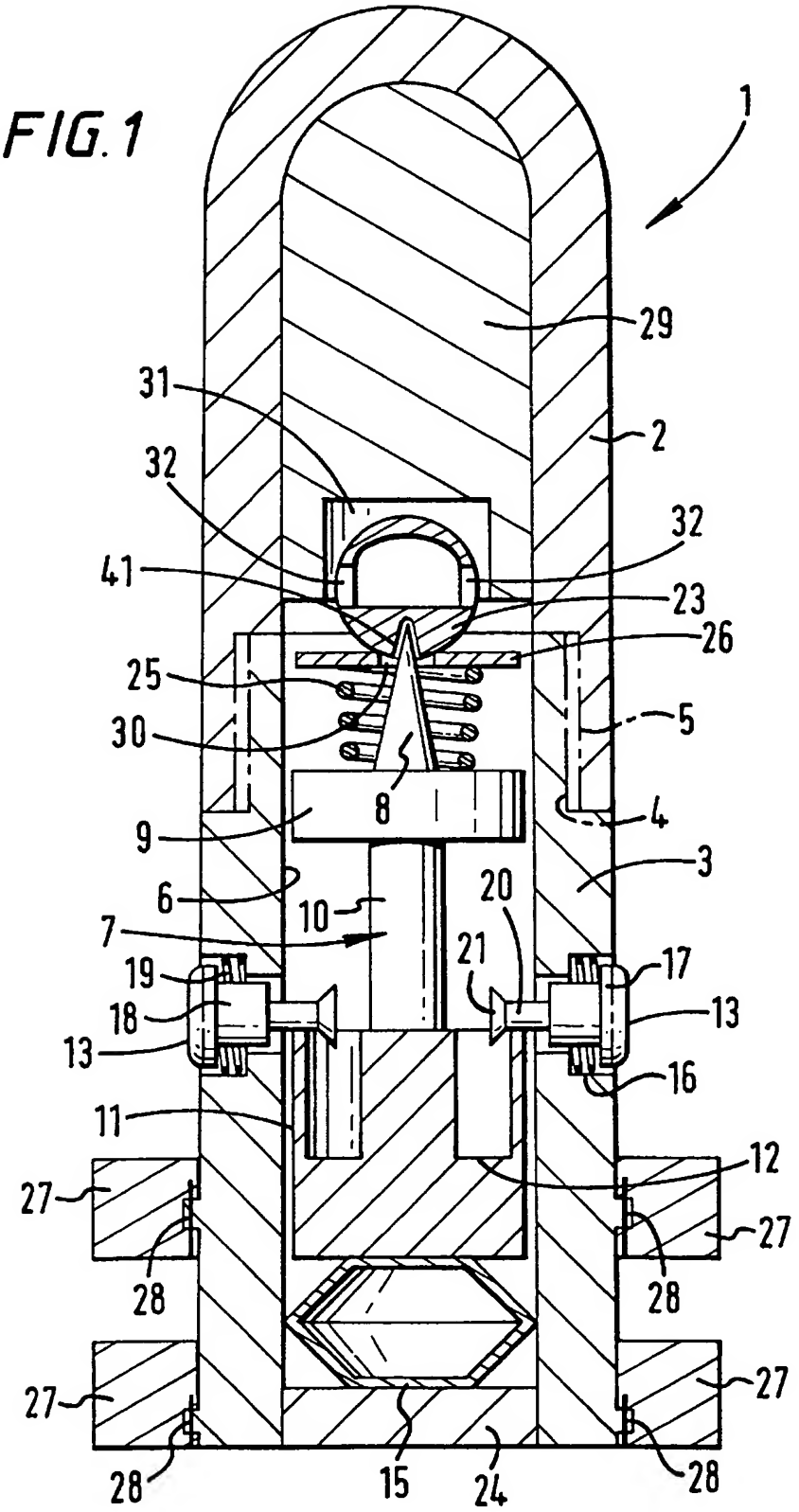
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FIG. 2

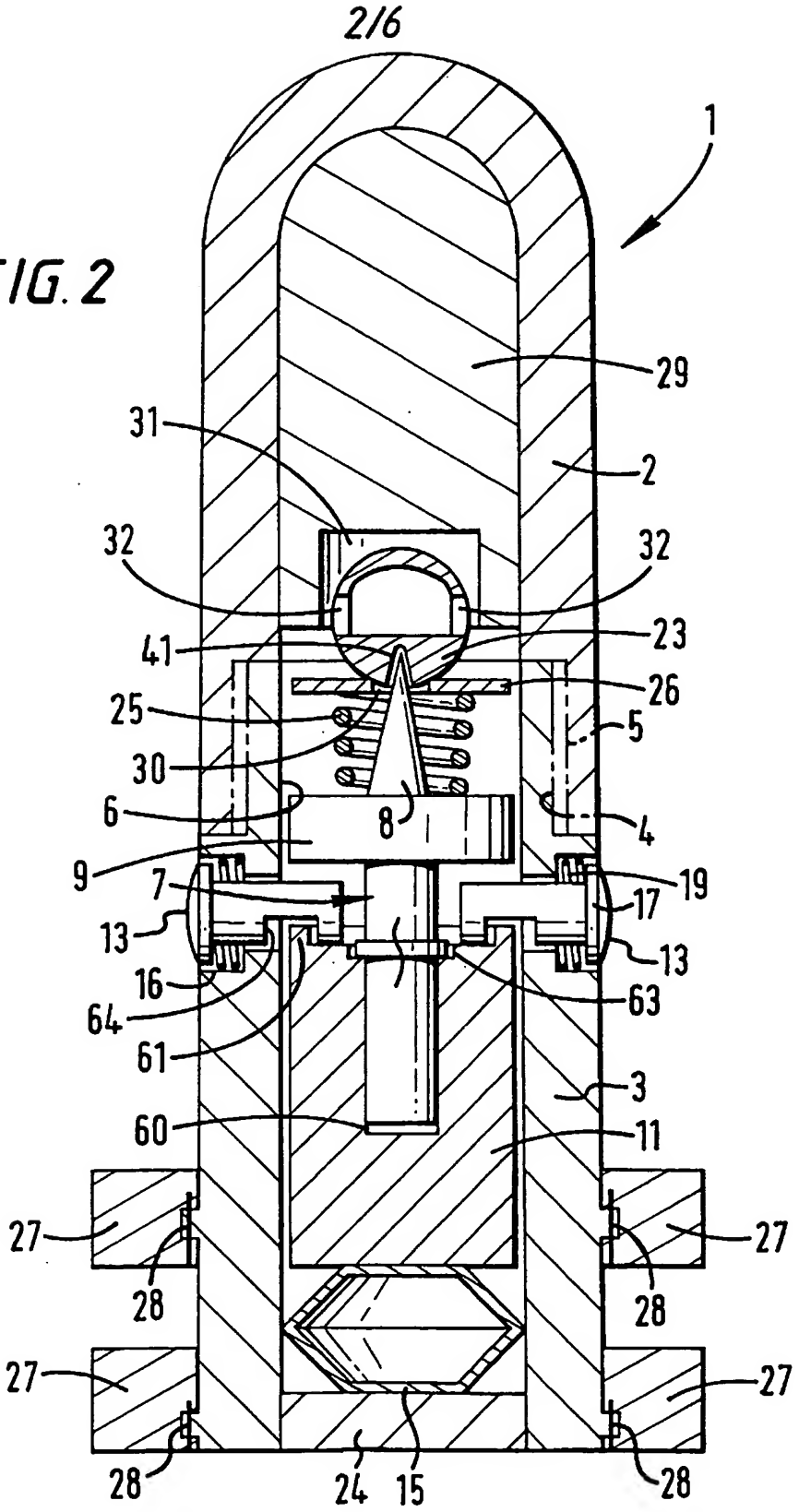
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FIG. 3

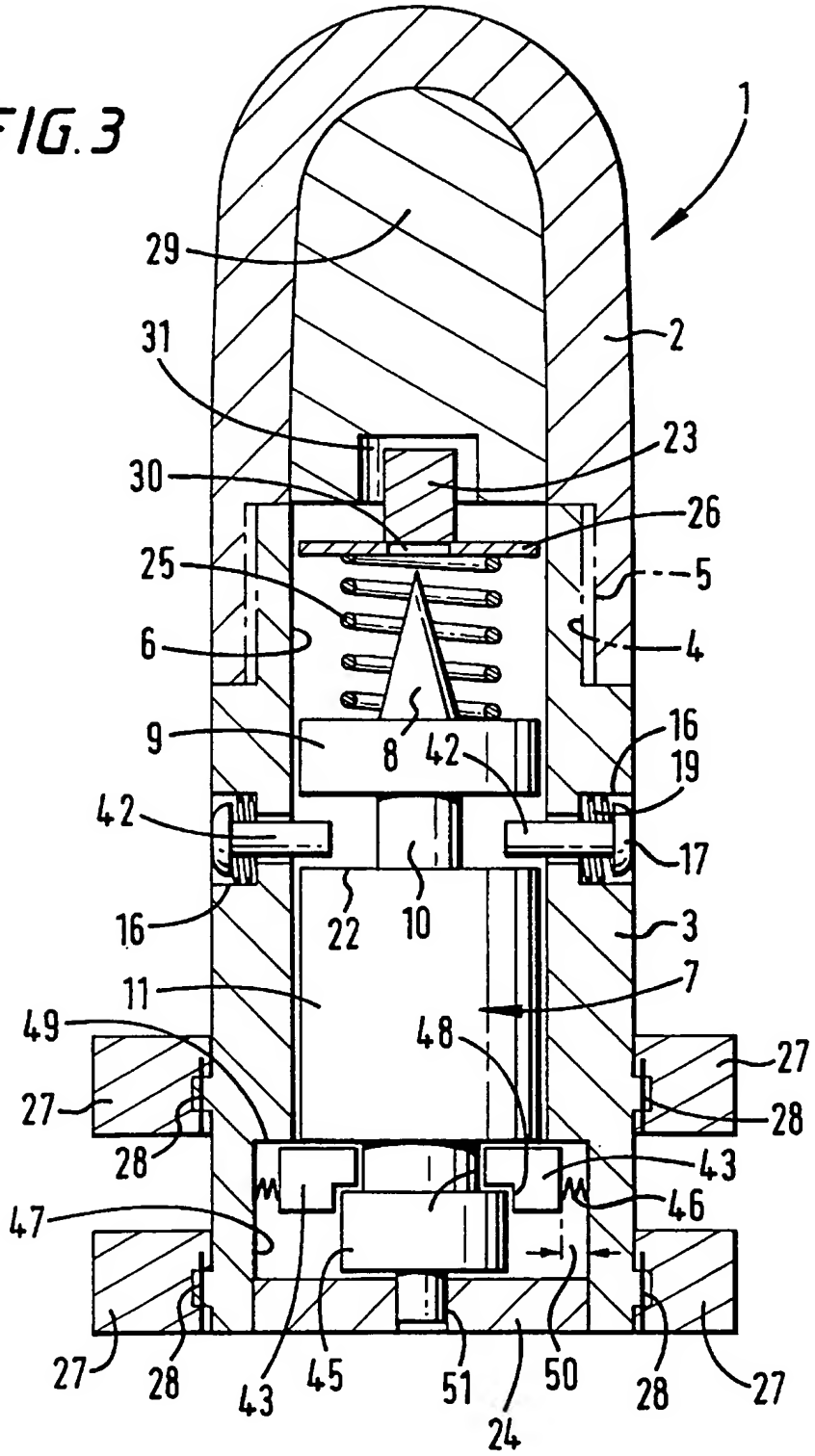
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FIG. 4

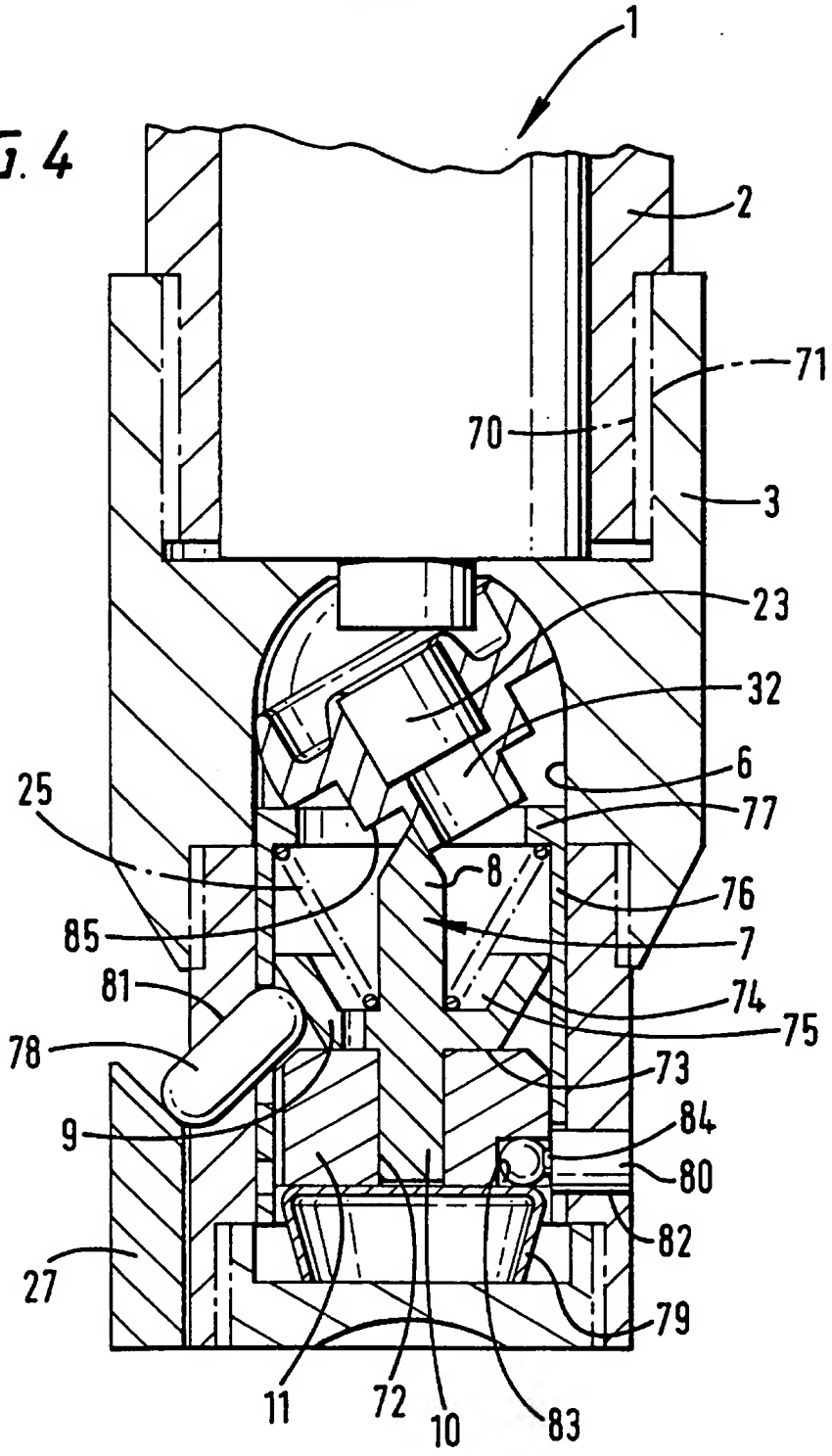
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FIG. 5(a)

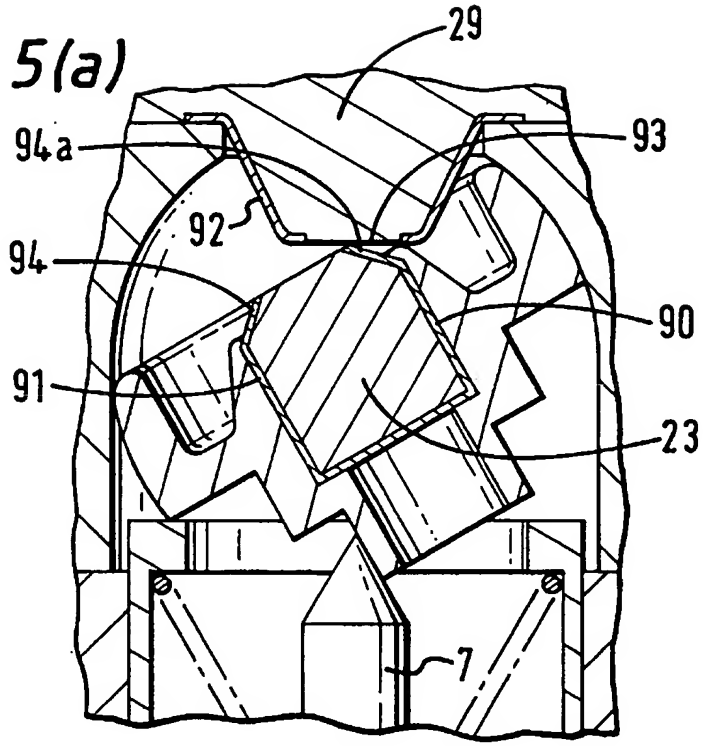


FIG. 5(b)

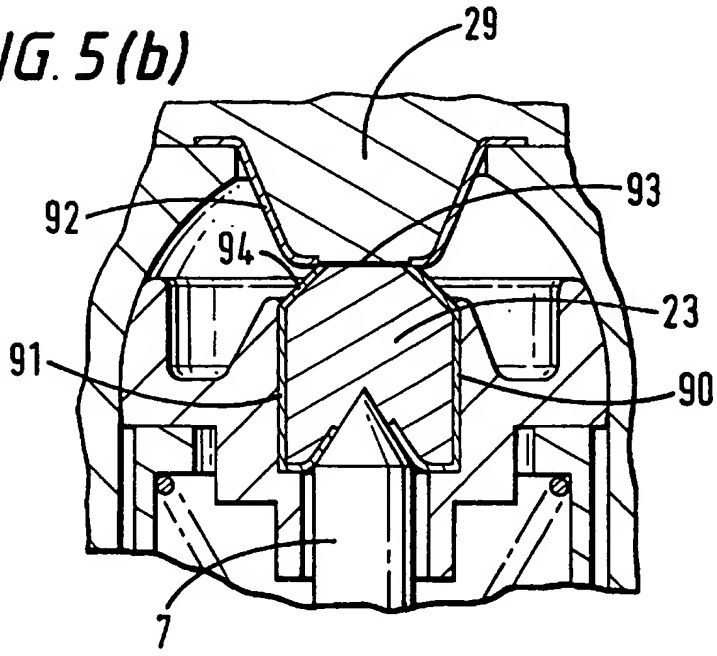
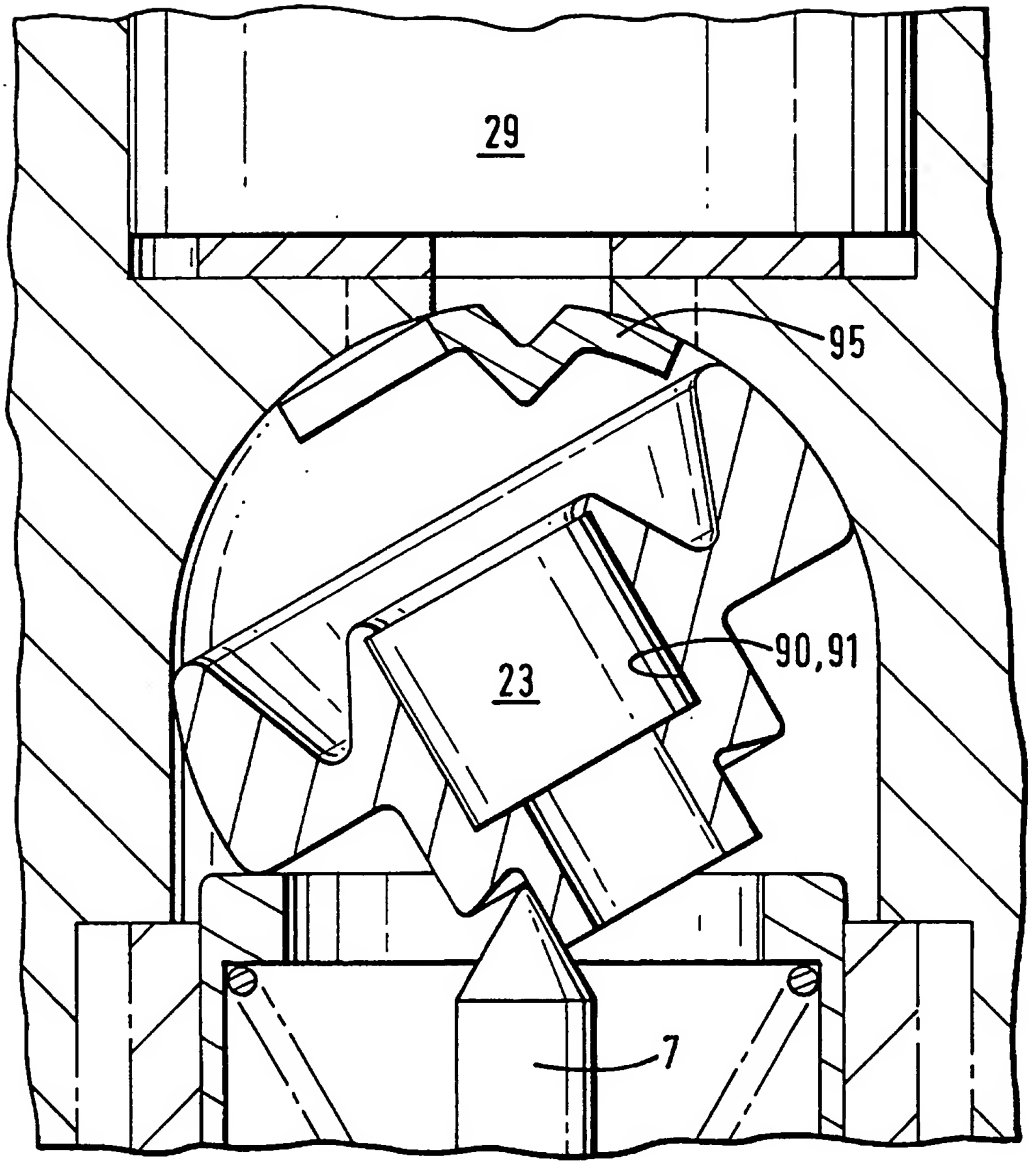


FIG. 6



INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 99/01042

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F42C15/24 F42C15/26 F42C15/192

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F42C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 424 890 A (L. DERVAUX) 26 May 1911 (1911-05-26) page 2, line 7-40; figures 5,6	1-8, 11-13, 15-17, 19-21
X	US 2 537 855 A (H. PORTER) 9 January 1951 (1951-01-09) the whole document	1-4, 9-15, 17-23
X	FR 863 175 A (A. GAZDA) 25 March 1941 (1941-03-25) the whole document	1-3, 11-14, 17,19-21
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 1999	16/08/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Van der Plas, J

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INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/GB 99/01042

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category '	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	FR 71 906 E (SOCIÉTÉ TECHNIQUE DE RECHERCHES INDUSTRIELLES) 14 March 1960 (1960-03-14) the whole document	1-3,5-8, 16-18,27
X	FR 627 004 A (B. PANTOFLICEK) 24 September 1927 (1927-09-24) the whole document	1-3,5-8, 16-18,27
X	US 2 845 866 A (J. JASSE) 5 August 1958 (1958-08-05) column 2, line 66 - column 3, line 54 column 4, line 21-38 column 4, line 57-69; figures 1-8	1-3,9, 12,17,19
X	CH 79 515 A (EHRHARDT & SEHMER) the whole document	1-3,13, 15,17,20
X	US 2 564 797 A (P. THOMPSON) 21 August 1951 (1951-08-21) the whole document	1-4,16, 17,19, 22-27
A	US 2 458 405 A (H. NICHOLS) 4 January 1949 (1949-01-04) figures 1-5	23-26
A	DE 308 558 C (ZÜNDER- UND APPARATEBAU) 4 November 1917 (1917-11-04) the whole document	18
A	US 2 554 586 A (R. MILLER) 29 May 1951 (1951-05-29)	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/GB 99/01042

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 424890 A		NONE	
US 2537855 A	09-01-1951	NONE	
FR 863175 A	28-03-1931	CH 207871 A	
		GB 541175 A	
FR 71906 E	14-03-1960	BE 540826 A	
		FR 71903 E	14-03-1960
		FR 71904 E	14-03-1960
		FR 71905 E	14-03-1960
		FR 71911 E	14-03-1960
		FR 1206605 A	10-02-1960
FR 627004 A	24-09-1927	NONE	
US 2845866 A	05-08-1958	BE 533457 A	
		CH 324218 A	
		FR 1096650 A	22-06-1955
		GB 760905 A	
		NL 97798 C	
		NL 239855 A	
CH 79515 A		NONE	
US 2564797 A	21-08-1951	GB 615640 A	
		US 2639669 A	26-05-1953
US 2458405 A	04-01-1949	NONE	
DE 308558 C		NONE	
US 2554586 A	29-05-1951	NONE	